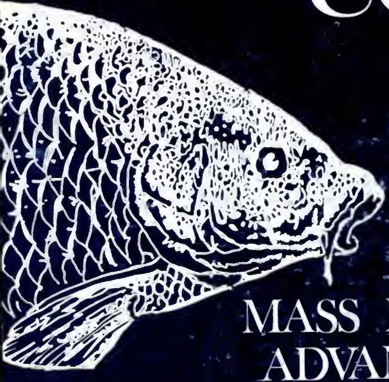
FAO Training Series 9

COMMON CARP

2



MASS PRODUCTION OF ADVANCED FRY AND FINGERLINGS IN PONDS

FAO Training Series **9**

COMMON CARP

PART 2

MASS PRODUCTION OF ADVANCED FRY AND FINGERLINGS IN PONDS

Food and Agriculture Organization of the United Nations
Rome, 1985

FAO welcomes requests for translating and adapting its material into local languages. Such requests should be addressed to the Director, Publications Division.

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

P-44
ISBN 92-5-102302-6

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying or otherwise, without the prior permission of the copyright owner. Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, Publications Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

© FAO 1985

PREFACE

This is the second part of an illustrated manual on the large-scale propagation of *Cyprinus carpio,* the common carp. It provides details about the advanced technology which has recently been developed in Hungary by using two types of hatchery earthen ponds for mass production of carp fry and fingerlings.

The first part of this manual on the common carp covers **Mass production of eggs and early fry** and appears as Volume 8 in the same FAO Training Series.

The text of this book was prepared in Hungary at the Warm-water Fish Hatchery (TEHAG) located at Százhalombatta, in collaboration with the FAO Inland Water Resources and Aquaculture Service of the Fishery Resources and Environment Division. The authors are Dr L. Horváth and Dr G. Tamás, biologists responsible for hatchery production management at Százhalombatta and Dr A.G. Coche, Senior Fishery Resources Officer (Aquaculture), Fisheries Department, FAO, Rome.

The illustrations are reproductions of the original water-colours by L. Horváth, father of the senior author. Layout and design are by A. Wolstad.

Intended as a teaching aid, a filmstrip is available separately, consisting of the colour transparencies of the original water-colours.

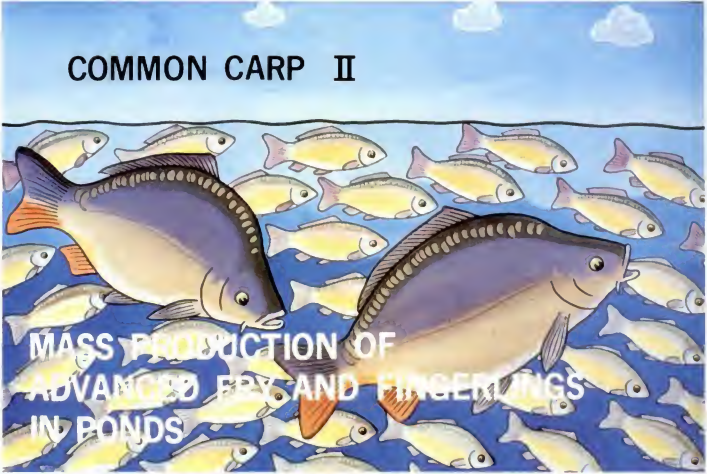
CONTENTS

	Page
Introduction	5-11
Biology of juveniles production in earthen ponds	12-21
Production of advanced fry	22-51
Production of fingerlings	52-75
Overwintering season	76-79
Organization of fish production	80-83

TABLE 1

Selected data on the production of advanced fry and fingerlings of common carp 84-85

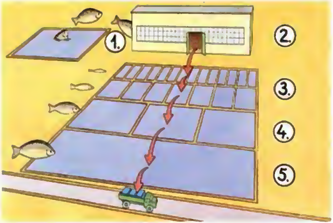
COMMON CARP II



MASS PRODUCTION OF ADVANCED FRY AND FINGERLINGS IN PONDS

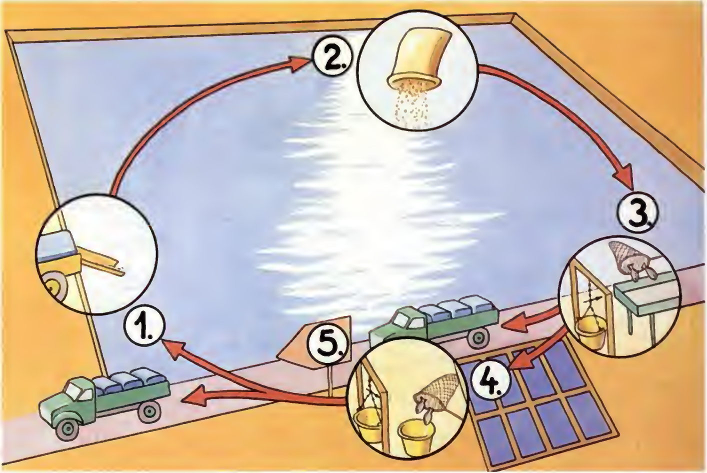
1. COMMON CARP PART 2 – MASS PRODUCTION OF ADVANCED FRY AND FINGERLINGS IN PONDS

This is the second part of an illustrated manual on the large-scale propagation of *Cyprinus carpio*, the common carp.
It provides details about the advanced technology which has recently been developed in Hungary for the mass production of carp fry and fingerlings in earthen ponds.
Selected data are summarized in Table 1.



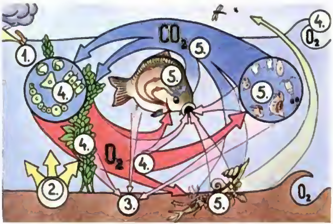
2. In **Part 1** of this manual we have seen how artificial propagation may be used for the mass production of carp eggs and early fry **(1, 2)**.
Part 2 explains how to use two types of hatchery earthen ponds for the successive mass production of the advanced fry **(3)** and fingerlings **(4)** of common carp.
Using these juveniles, marketable-size fish are then produced in fattening ponds **(5)**.

This One
S6J7-TUX-4YC1



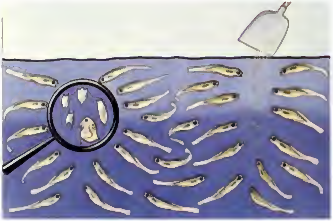
1.
2.
3.
4.
5.

3. **In temperate zones the production of table fish** starts in spring in the second year, with **(1)** the stocking of carp fingerlings in fattening ponds. **(2)** They are well fed until autumn, when they reach the average weight of 200-300 grams. **(3)** After being harvested and sorted by size, **(4)** they are then stocked in smaller ponds for overwintering.
The following spring, the third year starts and continues in the same way until autumn when the carp average 1-2 kg each. **(3)** They are harvested and sorted by size, **(5)** part of them are marketed **(4)** and the rest are overwintered.
In the spring, the marketable-size fish are sorted and marketed, some being possibly kept as young broodstock.
In tropical zones this production cycle can be shortened by at least one year, since the growth of the carp is not restricted to certain seasons.



4. Carp juveniles are reared in earthen ponds where they become part of the **biological production cycle.**
It will be shown to you which factors are involved in this cycle and how they may affect fish production.

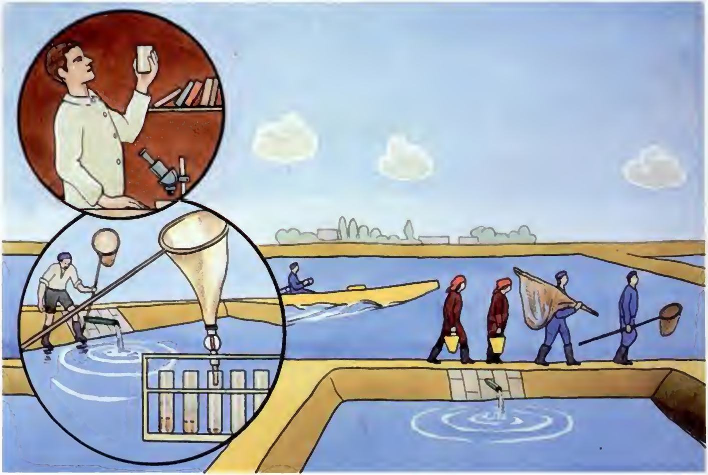
5. In the carp ponds, many different organisms live together and interact with each other.
You should become familiar with the most common **phytoplankters, zooplankters, insects** and **vertebrates** living in warm earthen ponds.



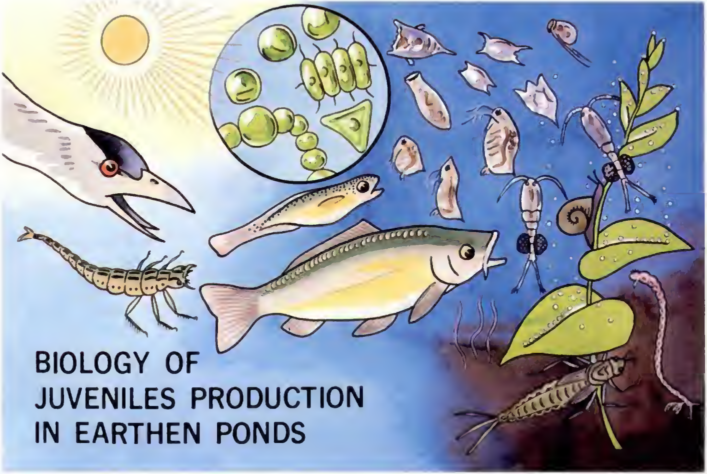
6. The technology for the production of 3-cm **advanced carp fry** is then described in detail, using well prepared and closely managed earthen ponds for one month.

7. Carp **fingerlings** 10-40 g in size are produced during the following rearing period, in larger ponds.
The technology will be discussed in the next section of this manual.

8. In temperate climates, the water temperature in the ponds may reach below 10°C.
If this is the case, the fingerlings should **overwinter** under appropriate management, which is briefly illustrated.



9. In a final section, the efficient **organization** of fry and fingerling production is emphasized.



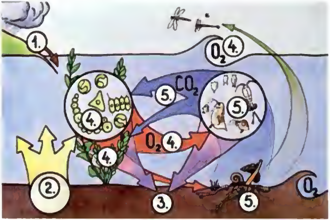
BIOLOGY OF JUVENILES PRODUCTION IN EARTHEN PONDS

10. BIOLOGY OF JUVENILES PRODUCTION IN EARTHEN PONDS

When earthen ponds are used for the large-scale production of carp juveniles, these become part of **the biological production cycle.**

Solar energy, through photosynthesis, contributes to the production of vegetal organic matter in the ponds: this phytoplankton forms the basis for the development of a mass of minute animals known as zooplankton. Juvenile carp feed voraciously on zooplankton, choosing the size which best corresponds to their own mouth size.

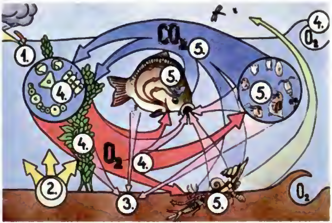
Predators consume small carp and losses can be great.



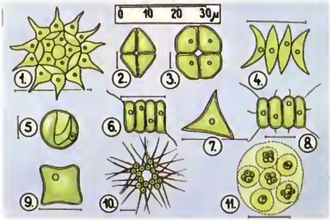
11. Looking more closely at the biological cycle, it can be seen that several other factors are involved in determining **the productivity of an earthen pond.**

(1) Soil erosion washes in nutrients, and **(2)** bacterial activity at the bottom of the pond releases others. **(3)** The organic matter of the bottom mud, which consists of thousands of dead organisms, is in this way partly recycled into the production system. **(4)** Oxygen in the water originates mostly from absorption at the surface and from plant photosynthesis. **(5)** Carbon dioxide (CO_2) is generated through the respiration process of animals and utilized by plants.

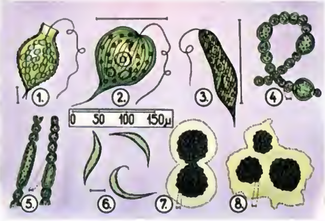
When no juvenile carp are present, the volume of mud in the ponds steadily increases.



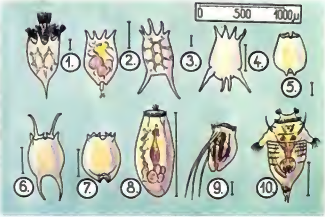
12. On the other hand, when **juvenile carp** are present, plankton and the organisms at the bottom of the pond are consumed regularly and transformed into fish flesh, as shown by the yellow arrows.
The biological cycle (1-5) remains basically the same, except for this accumulation of energy within the fish and their release of metabolic by-products in the form of urine, faeces and carbon dioxide.



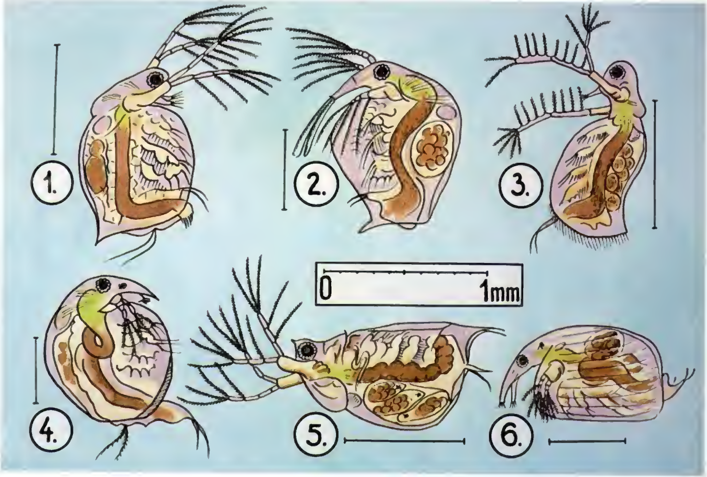
13. In the following pictures, a closer look is taken at some of the **living organisms** which most influence the biological production of juvenile carp in earthen ponds.
These microscopic **green algae** belong to the phytoplankton. Some examples are species of **(1)** *Pediastrum*, **(2, 3)** *Crucigena*, **(4, 6, 8)** *Scenedesmus*, **(5)** *Chlorella*, **(7, 9)** *Tetraedron*, **(10)** *Richteriella*, and **(11)** *Gloeococcus*.



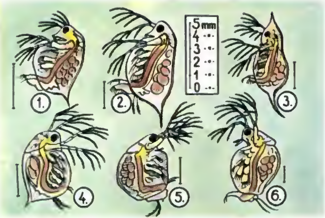
14. High densities of both blue-green algae and of flagellates are undesirable in rearing ponds. **(4-8) Blue-green algae** indicate unbalanced environmental conditions. **(1-3) Flagellates** develop well in the presence of water pollution.
Some examples of flagellates are species of **(1)** *Trachelomonas*, **(2)** *Phacus* and **(3)** *Euglena*. As blue-green algae: **(4)** *Anabaena*, **(5)** *Aphanizomenon*, **(6)** *Dactilococcopsis*, and **(7, 8)** *Microcystis*.



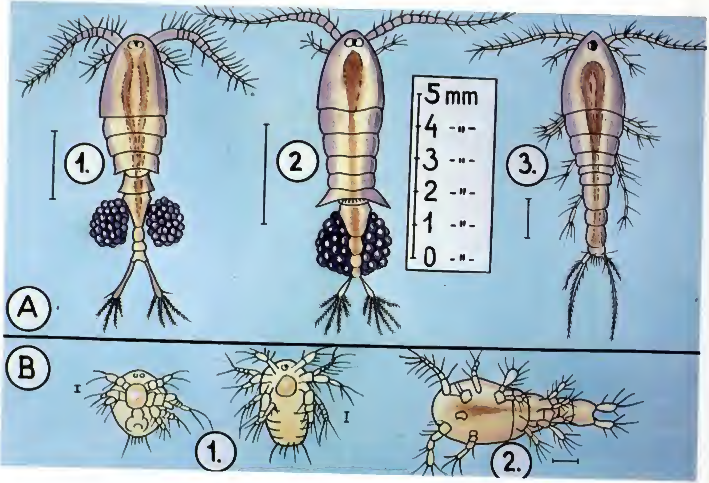
15. The slow-moving **rotifers** are the most important group of microscopic animals for the rearing of early fry. They belong to the zooplankton.
Some examples are species of **(1, 3)** *Keratella*, **(2, 4-7)** *Brachionus*, **(8)** *Asplanchna*, **(9)** *Filina*, and **(10)** *Synchaeta*.


1.
2.
3.
0
1mm
4.
5.
6.

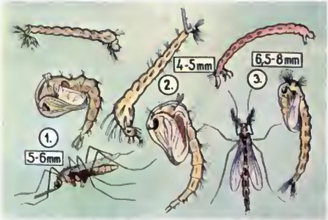
16. **The small cladoceres** (0.2-0.5 mm) gradually gain in importance as the fry grow in size. They also belong to the zooplankton and they may compete with the rotifers for food. Some examples are species of **(1)** *Ceriodaphnia,* **(2)** *Bosmina,* **(3)** *Diaphanosoma,* **(4)** *Chydorus,* **(5)** *Scapholeberis,* and **(6)** *Alona.*



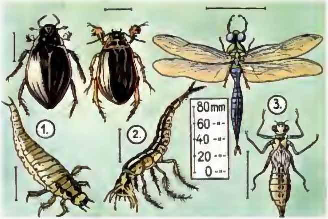
17. **Larger cladoceres** become an important natural food supply during the second stage in the fry rearing process. Before this, they are undesirable as they compete for food with smaller zooplankters. Some examples are species of **(1-3, 5)** *Daphnia,* **(4)** *Simocephalus,* and **(5)** *Moina.*


1.
2
3.
5 mm
4 -"-
3 -"-
2 -"-
1 -"-
0 -"-
A
B
1.
2.

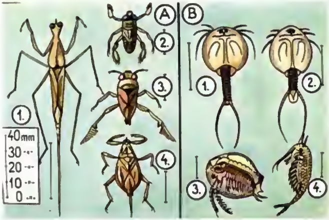
18. **(A) Adult copepods** are zooplankton predators which are very dangerous for early carp fry.
Some examples are species of:
(1) *Cyclops*, **(2)** *Diaptomus*, and **(3)** *Canthocamptus*.
On the other hand, **(B) juvenile copepods** could be very useful natural food for carp fry, but in practice they cannot be separated from the adults.
Several juvenile stages exist such as:
(1) the nauplius and **(2)** the copepodite stages.



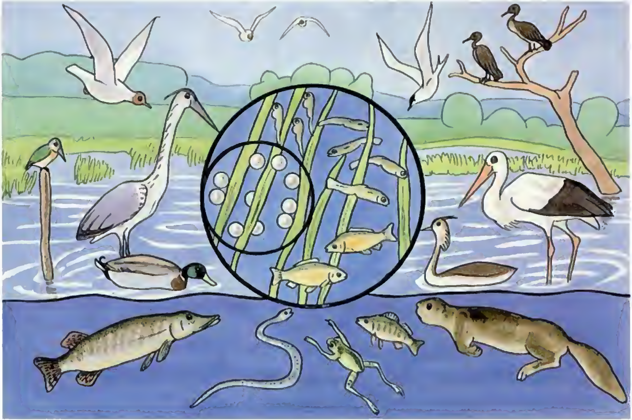
19. Larvae and pupae of **mosquitoes (1, 2)** and **chironomids (3)** are an important source of food for the advanced carp fry.
The mosquito larvae and pupae live near the water surface, hidden among the aquatic vegetation such as, for example, species of **(1)** *Anopheles* and **(2)** *Culex*.
Chironomid larvae and pupae such as **(3)** *Chironomus plumosus* live in the bottom mud of the ponds.



20. In pond areas where dense aquatic vegetation is present, large **insect larvae** may develop in great numbers, preying voraciously on juvenile carp.
These are, for example, the water beetle larvae **(1)** *Hydrous piceus* and **(2)** *Dytiscus marginalis,* as well as the dragonfly such as **(3)** *Anax imperator.*

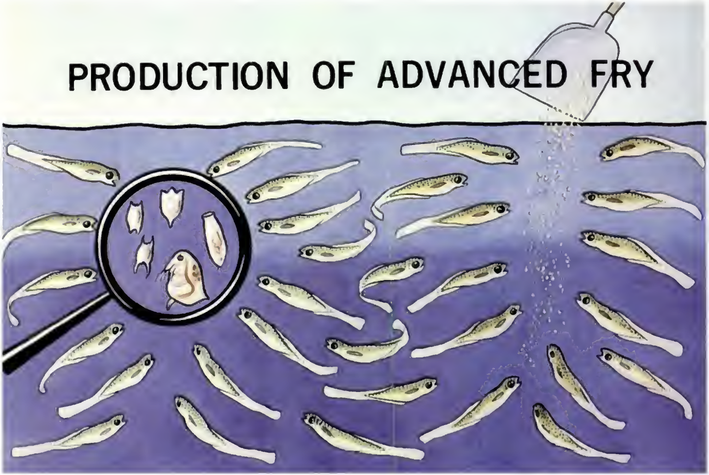


21. **(A)** Predatory **aquatic insects** may also cause considerable losses among carp fry in the rearing ponds, if control measures are not applied.
Some examples are species of **(1)** *Ranatra,* **(2)** *Corixa,* **(3)** *Notonecta,* and **(4)** *Nepa.*
(B) Losses may also result from small **crustaceans** such as species of **(1)** *Triops,* **(2)** *Lepidurus,* **(3)** *Limnadia,* and **(4)** *Branchipus.*



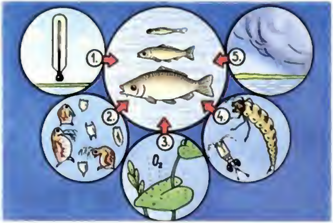
22. Important fish losses in the rearing ponds may also be caused by **vertebrate predators** such as frogs, snakes, fish and birds.

PRODUCTION OF ADVANCED FRY

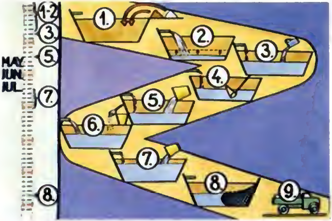


23. PRODUCTION OF ADVANCED FRY

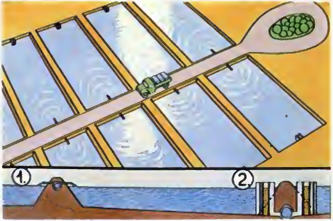
The intensive production of advanced carp fry about 3 cm long, in well prepared earthen ponds, takes 21-30 days.



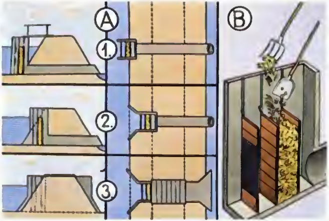
24. The chief **environmental factors** which influence carp fry production during this first rearing period are: **(1)** water temperature, as fast growth and good survival require at least 18°C; **(2)** quality and availability of natural food, as the early fry feed on 0.15-0.2 mm zooplankters such as rotifers; **(3)** dissolved oxygen content which should reach 5-8 mg/l; **(4)** presence of predators such as insect larvae and large copepods which may cause high losses; **(5)** weather conditions, changes of the atmospheric pressure, sudden temperature variations, and strong winds, often resulting in poor survival.



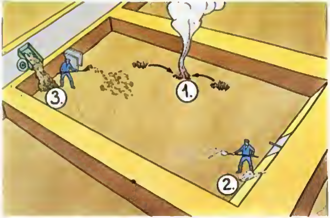
25. This is a **summary of the technology of the production of advanced fry** in fry ponds.
Its most important feature is the good preparation of the dry ponds, including fertilization **(1)**. After half filling the ponds **(2)**, a selective chemical treatment of the water **(3)** eliminates the cladoceres and the copepods which encourages the strong development of rotifers **(4)**. Then the ponds are stocked with early fry **(5)**. Some supplementary feed is distributed **(6)**, and larger zooplankters are seeded **(7)**. Advanced fry are harvested 21-30 days after the filling of the ponds, depending on environmental conditions **(8)**. They are then transported to fingerling ponds for further rearing **(9)**.



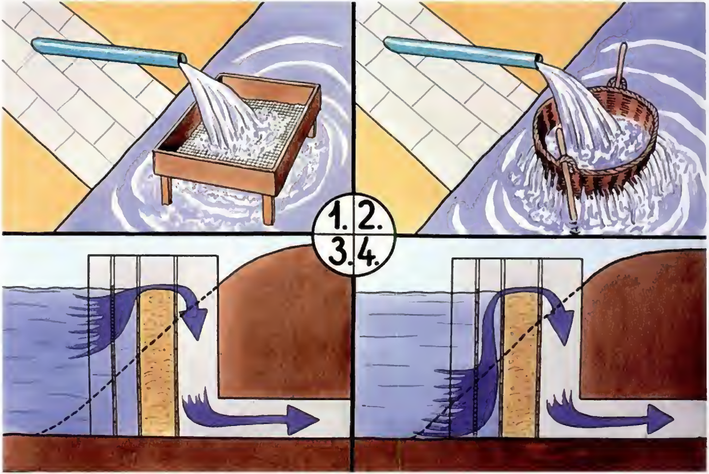
26. **The fry rearing ponds** are relatively small, generally varying from between 0.01 and 1 ha in size. Their depth averages 1 m.
(1) They should have a good water supply, a regularly sloping bottom ensuring complete drainage, and an adequate water-level control structure at the outlet.
Good road access to all ponds is also essential.



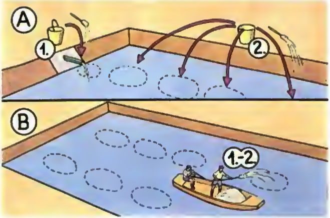
27. **(A) The pond outlet** may be either a monk or a sluice. The monk structure may be built in front of the dike **(1)** or as part of it **(2)**.
In both cases, the water is evacuated by a pipe buried beneath the dike.
The sluice structure is built across the dike and there is no need for a pipe **(3)**.
(B) The water outlet provides the possibility of controlling the water level in the pond by using two rows of planks, the space between them being filled with compact clayey soil. In front of these planks, a screen on top of a third row of planks prevents the fish from leaving the pond.



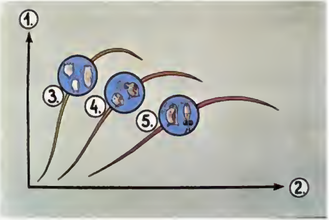
28. The fry pond has been kept dry since the last fry production season. As the new season starts it **is prepared** with great care.
(1) The dry bottom is cleaned of all vegetation, which is burnt.
(2) Quicklime is spread over all the bottom of the pond at the average rate of 150 kg/ha, for sterilization and to improve the soil structure.
(3) Organic fertilizer such as pig manure is then distributed at the average rate of 5 tonnes/ha to ensure a good growth of the natural food organisms.


1.
2.
3.
4.

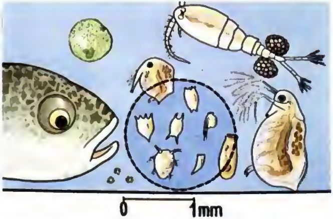
29. The fry pond is half filled.
Care should be taken **to control the entrance of predatory fish.** This can be done by filtering the water through a fine mesh material, **(1)** placing a filtering box or **(2)** a simple woven basket **(2)** under the inlet pipe.
With a more elaborate inlet structure such as a monk, the depth at which the water is drawn from the feeding canal can also be varied.
(3) Surface water or **(4)** water from the bottom can be used according to the position of the screen in the front groove of the monk.



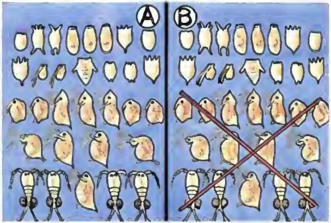
30. **(A)** In small ponds (max. 400 m^2), **Inorganic fertilization** is applied from the banks in two steps.
(1) During the filling of the pond, ammonium nitrate fertilizer containing 43% nitrate nitrogen is thrown in front of the water inlet which will gradually dissolve and spread through the entire water of the pond, at the rate of 150 kg/ha.
(2) When the pond is full, 100 kg/ha of superphosphate fertilizer (18% active ingredient) is spread over the water surface from the banks.
(B) In larger ponds, these two fertilizers are mixed and applied together from a boat to the whole pond surface.



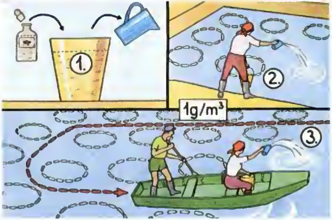
31. Under the stimulus of the strong fertilization, the various groups of **zooplankters** develop vigorously. Their relative abundance (1) varies with time (2).
First the rotifer population develops toward its peak of abundance (3).
This is immediately followed by the small cladoceres (4) and later by the large cladoceres and the copepods (5) which successively become predominant.
This is what would happen normally in the fry ponds if they were not chemically treated for the selective elimination of certain organisms.



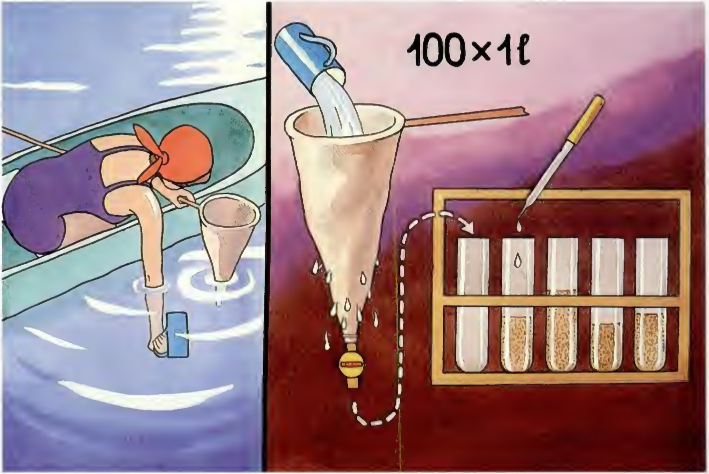
32. If the size of the mouth of the early carp fry is compared with the individual size of the zooplankters, it becomes evident that only the **rotifers** can be easily eaten by the small fish. They are the most desirable group of food organisms for the early carp fry which feed on them eagerly.



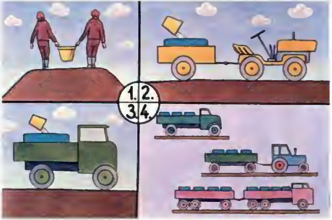
33. In the newly filled pond, the whole range of zooplankters would normally start to develop as described above **(A).** However, for the moment, it is only the rotifers which are valuable food for the growth of the early fry. Therefore, **the larger zooplankters should be selectively eliminated (B).** This will reduce the food competition of the cladoceres to the profit of the rotifers and it will increase the survival of the rotifers by eliminating their predators, the copepods. The largest copepods which prey on the early fry will also be eliminated.
A larger population of rotifers will be present in the pond and it will develop over a longer period of time. It is only when the early carp fry have increased in size that the cladoceres and the copepods will start to appear again and to develop normally.



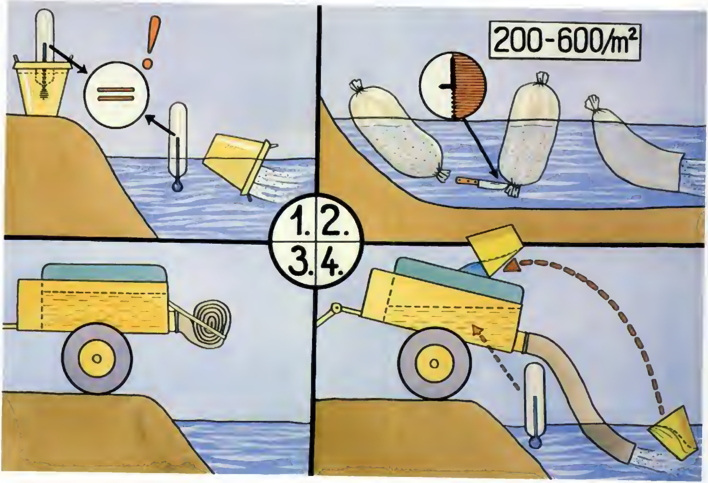
34. The half-full **pond is chemically treated** for the selective elimination of the cladoceres and the copepods. The rotifers are not affected by this treatment.
Calculate the volume in cubic metres of the water present in the pond. Take 1 g/m^3 water of an agricultural **insecticide** such as Flibol, Dipterex or Masoten (an organophosphoric acid ester or trichlorfon). **(1)** Dissolve the total required quantity of insecticide into 10 l of water and apply this concentrated solution evenly to the pond.
(2) If it is a small pond, the solution is thrown on to the surface of the water from the banks.
(3) If the pond is large, a boat is necessary. The final concentration of the insecticide in the pond water should be 1 mg/l or 1 part per million.


100×1ℓ

35. To see whether the selective treatment has been effective, the **zooplankton should be regularly checked.**
There should be no cladocere and no copepod for the next 5 days, but the rotifer abundance should increase rapidly.
To check this, filter 100 l of pond water through a plankton net with 120-180 micron mesh. Pour the plankton sample into a graduated glass tube. Add 1-2 drops of formalin to the tube to kill the zooplankters. An hour should pass before their sedimentation at the bottom of the tube. The volume of rotifers present should then be read.
When it reaches 2-3 ml per 100 l water, the pond is ready to be stocked with the early fry. Remember that this usually takes 4-5 days.
The preparation of the ponds and the hatchery production of the early fry should therefore be planned accordingly!



36. When the rotifer population has reached its optimum level about 4-5 days after the chemical treatment, **the early fry should be stocked** as soon as possible. They are **transported** from the hatchery to the ponds by various means, depending on the length of time the journey will take. Close to the hatchery, the transport can be done on foot, **(1)** carrying them in 30 l plastic pails or **(2)** using a small tractor/trailer with a fibreglass water tank. For longer distances, **(3)** small trucks and **(4)** lorries are used, equipped with oxygenated water tanks.
During this transport, the density of early fry varies from 1 to 2 million per cubic metre of water. Transport in plastic bags is also common practice, as described in the first manual.


200-600/m²
1. 2.
3. 4.

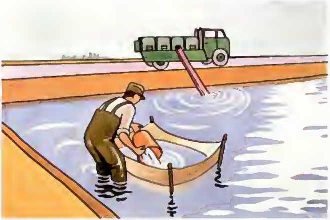
37. The early fry are **stocked in the fry ponds** at the rate of 200-600 ind./m², according to the size of the pond and its potential productivity. Smaller ponds, highly productive, are stocked at the highest density.

(1) It is very important to ensure that the water temperature in the transport container does not differ more than 2°C from that in the pond.

After a long journey in a plastic bag, for example, **(2)** the bag should be immersed in the pond water for at least half an hour before the fry are released into the pond.

(3) In a fibreglass tank the temperature is equalized by gradually adding pond water to the tank and it is only when the water temperatures are very similar that stocking is done, **(4)** using the flexible canvas tube from the inclined tank.

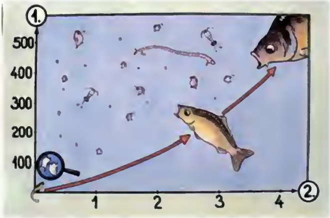
About a week after this stocking, the half-full pond should begin to be filled, raising its water level gradually until it is completely full.



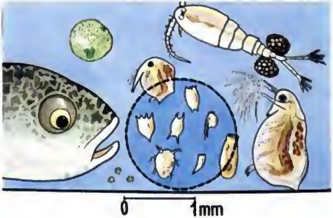
38. When stocking large fry ponds from a heavy lorry, the fish are transferred to the pond by means of a **plastic chute.**

In such large ponds the risks of losses are very great.

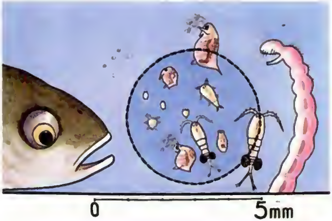
It is advisable to place 100-200 early fry in a small **netting enclosure** to control their first few weeks' survival.



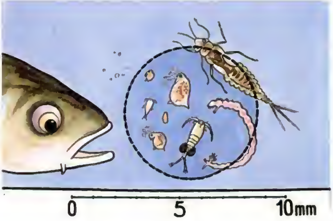
39. Soon after their stocking into the pond, the early fry voraciously feed on the abundant rotifers present. Their growth is fast and their survival rate high. But as they grow they progressively require larger preys to feed on and the individual size of the natural food organisms which are available should gradually increase.
Three main **feeding phases** may be defined during this first month rearing in the fry ponds.



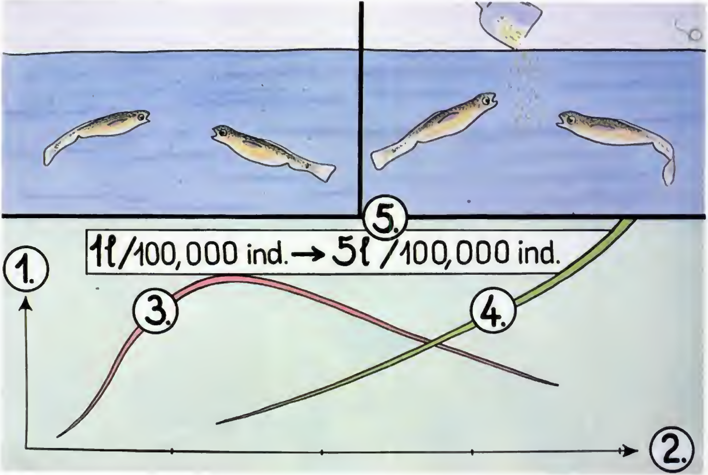
40. During the first 10 days after stocking, the early fry will preferably feed on **rotifers.**
Because of such heavy predation the abundance of the rotifer population will slowly decrease as the carp fry grow quickly. By the end of this period the individual size of the rotifers becomes too small to satisfy fully the needs of the fry.



41. From about the tenth to the twentieth day the best food for carp fry consists of **small cladoceres and copepods.**
The populations of these zooplankters have started to develop again in the pond about 5 days after the application of the chemical treatment which had eliminated them in favour of the rotifers.
It is also then that the stocking of the early fry had taken place and, a little later, that the pond had been completely filled. It is also during this period that zooplankton is added to the pond to assist its repopulation with larger food organisms, as shown later — see item 46.



42. During the last 5-10 days of this first rearing period, the fry feed on **all cladoceres and copepods.**
They are also able to consume **small insect larvae** such as chironomids and mayflies (*Cleon* sp.).


5.
1ℓ/100,000 ind. → 5ℓ /100,000 ind.
1.
3.
4.
2.

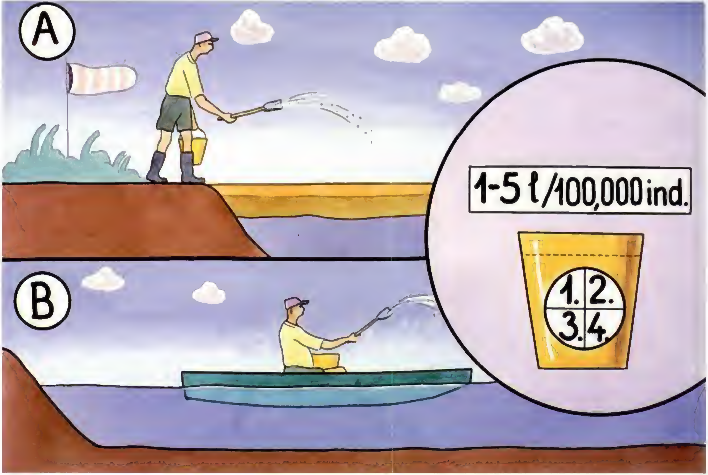
43. In addition to the natural food which is so important to early fry, it is necessary to provide **artificial food** to ensure the best possible growth and survival during this first month of rearing.

Although both natural and artificial feed are available to the fish from the beginning of the period, the quantity of each type of food consumed **(1)** varies with time **(2)**. Initially, only natural food is taken, its consumption reaching its peak about 10 days after stocking **(3)**.

This is followed by a reduction in natural food consumption as the preference for the artificial feed gradually increases **(4)**.

By the end of the month the fry consume relatively little natural food, and the predominance of artificial food is apparent.

It is therefore necessary to increase regularly the quantity of artificial food distributed daily during the rearing period **(5)**.


A
B
1-5 ℓ/100,000 ind.
1. 2.
3. 4.

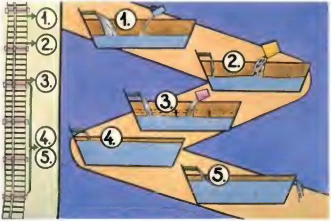
44. **The artificial food** consists of a mixture of equal parts of soybean meal **(1)**, wheat meal **(2)**, fish meal **(3)** and blood (or meat) meal **(4)**. It is in the form of a very fine dry powder made of 0.1-0.2 mm particles.

At the beginning of the period, it is distributed at the rate of 1 litre per 100 000 fry. This daily feeding ration (DFR) gradually increases during the month up to 5 litres per 100 000 fry.

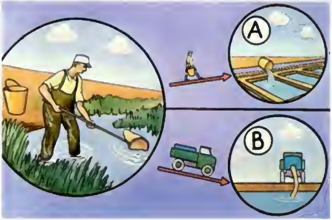
Food is distributed once a day in the morning or preferably several times daily, the DFR being then divided accordingly.

Two **feeding methods** are used. **(A)** In small ponds, the artificial food is scattered over the water surface from the banks. On windy days the direction of the wind should be taken into account, as it will tend to agglomerate the floating food in one part of the pond only.

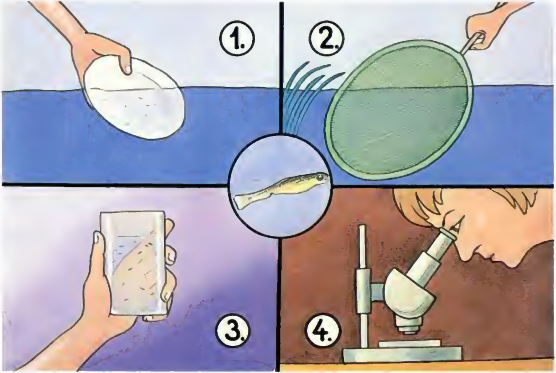
(B) In larger ponds, the powdered food is diluted with water in a bucket. The liquid mixture is then distributed from a boat at various places around the pond.



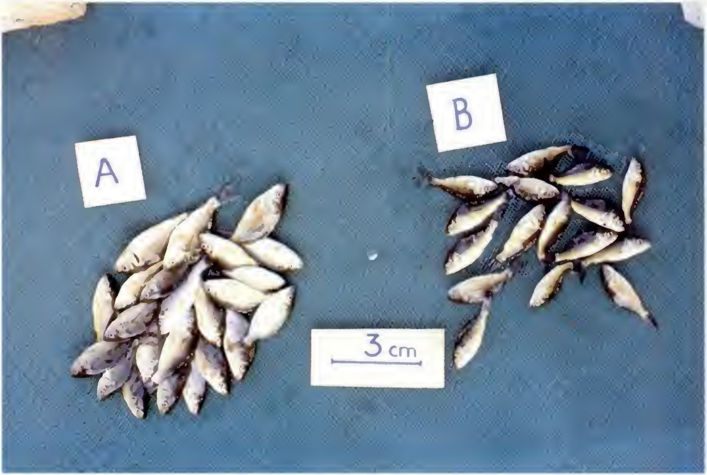
45. **The water management** of the fry pond is highly important, since its objective is to optimize the environmental conditions for the production of carp fry. It is carried out in five stages.
(1) After its preparation in the dry state, the fry pond is half filled with filtered water and the chemical treatment is applied. **(2)** About five days later, the early fry are stocked in the half full pond. **(3)** One week later, the filling of the pond is slowly completed, and larger zooplankton is stocked. **(4)** From now on, the water level is kept stable and additional water is supplied only to compensate for seepage and evaporation. **(5)** If by the end of the month the fry survival is good, the water supply is increased for a few days before harvesting to create an overflow.



46. About 12 days after the chemical treatment of the pond water to eliminate the **larger zooplankters**, it is advisable **to reintroduce** some of them as seeds, particularly the cladoceres *Moina* and *Daphnia*. These are collected from other ponds with a zooplankton net and transported either in buckets **(A)** or in a tank **(B)**.
In small fry ponds (100-400 m^2), a living biomass of 100-200 ml or about one full bucket of a dense zooplankton population is required.
In larger fry ponds, a 1-litre biomass should be sufficient. This zooplankton will rapidly reproduce in the well-fertilized pond to boost the resident population.

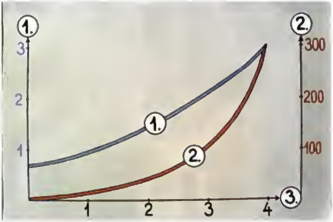


47. During the first rearing period, the growth, survival and health of the growing fry should be **regularly controlled.** **(1)** The fry may be observed directly in the pond, using a white plate as a background. **(2)** They may also be fished easily along the banks and in grassy areas, using a fine mesh dip net. **(3)** Their swimming behaviour together with their general condition can be observed in a glass of water. **(4)** The presence of ectoparasites can be detected with a binocular microscope.

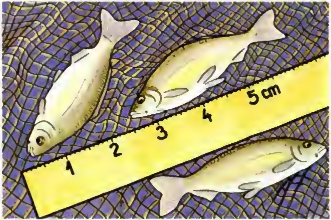

A
B
3 cm

48. What is a "good" or a "bad" fry?

	Good fry (A)	Bad fry (B)
Body shape:	deep, plump	slender, bighead
Colour:		
belly	deep yellow	yellowish
back	greyish green	dark
tail	bright, shiny	dull
Tail movement:	very rapid and hardly visible	slow and easily visible



49. The growth of the fry (1) in length and **(2)** in weight during this first rearing period varies according to the environmental conditions.
In general, however, if these conditions meet the average standards, **(1)** the total length of the fry in centimetres should reach about 3 cm and **(2)** their live weight in milligrams should **(3)** be about 300 mg by the end of the four-week period.



50. By the end of the first rearing period the young carp have become **advanced fry.** They measure from 2.5 to 3 cm in length, weighing from 200 to 300 mg each.

The survival rate during these 25-30 days usually varies from 30 to 60%.

51. The time has come **to harvest the advanced fry** and transfer them to larger ponds.

If the aquatic insects such as *Corixa* are too adundant, the pond is first treated with a dose of 1 ppm of an agricultural insecticide. The same chemical used for eliminating the larger zooplankters can be applied, see item 34.

(1) The water level is then slowly lowered through the outlet.

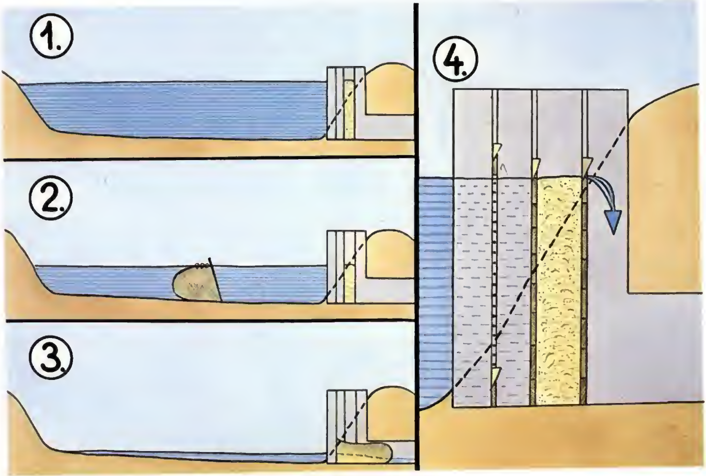
(2) When the pond is half drained, fishing starts with a fine-mesh seine net.

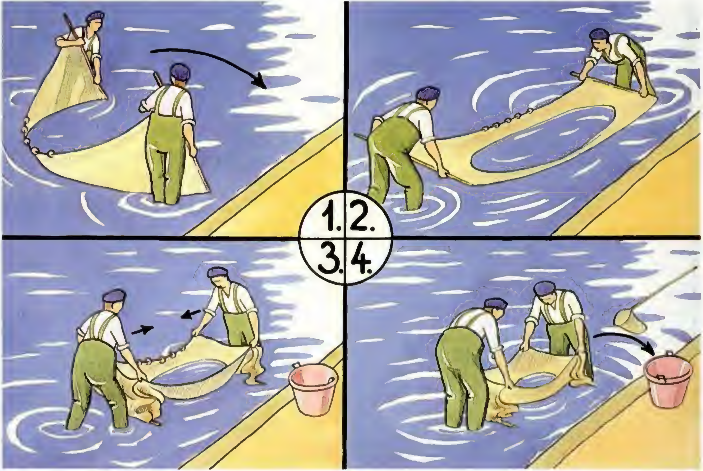
When most of the fry have been removed, the water depth is further reduced.

(3) Toward the end of the draining, a fixed trap is placed in the outlet and the remaining fry are captured as the pond is completely drained.

(4) During these operations, a long fine-mesh screen is slid into the outlet structure, in front of the two rows of wooden planks, to prevent the escape of fry.

Toward the end of the harvest this screen is replaced by the fixed trap as the last planks are being removed.

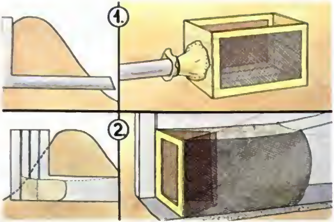

1.
2.
3.
4.


1.
2.
3.
4.

52. The fishing with **the seine net** is done along the pond banks. **(1)** Two fishermen pull the fine-mesh net until they have collected a certain number of fry. **(2)** They then turn the net toward the bank where they place it horizontally, keeping the fry in the middle. **(3)** They slowly concentrate the fry into a small pocket, being careful always to keep them under water. **(4)** The fry are transferred from the net to a water container, using a dip net.

Depending on the average size of the fry the mesh size of the seine net is either 2 mm square for 2-cm fry or 4 mm square for 3-cm fry.

In both cases, the netting is generally nylon curtain material. The seine net is 10-20 m long, according to the size of the pond, and about 2 m high. Secured at each end to 1.20-m wooden poles and mounted on ropes with floats and lead sinkers, it very effectively captures the fry in its baggy central part as it is dragged along the pond bottom.

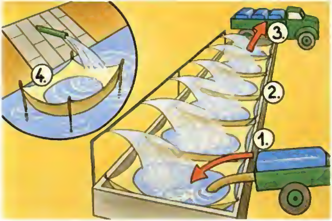


53. **The fixed trap** may be of two kinds.

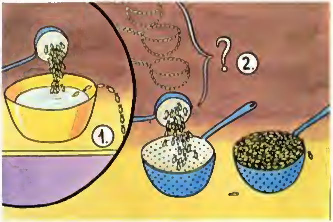
(1) A 1 x 0.6 x 0.6 m wooden frame covered on two sides only with fine-mesh netting may be directly attached with a flexible joint to the draining pipe.

(2) A V-shape net trap mounted on a wooden frame may be slid into the outlet structure and held open by a series of stretching lines.

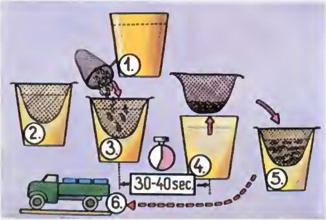
In both cases the fry should be constantly removed from the traps with a dip net to avoid great losses caused by the strong water current flowing through them.



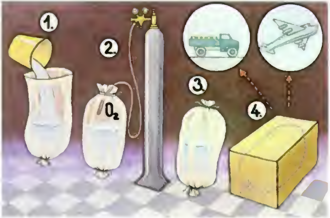
54. The advanced fry are transported from the ponds to **storage nets** to be sorted and counted before they are transported and stocked in fingerling ponds.
The nets (for example 2 x 1 x 0.8 m) are made of fine-mesh (2-4 mm) netting such as nylon curtain material. They are suspended from two sides into water-filled tanks supplied with a continuous inflow of water sprayed on the surface of each enclosure. A light frame is placed into each net to keep its bottom part down. **(1)** The fry are transferred into the nets on arrival from the ponds. **(2)** They are stored there without feeding for 24 hours maximum. **(3)** It is very easy to transfer them to the lorries for transport. **(4)** A similar system can be built in a corner of a pond, next to the water inlet, by attaching a similar storage net inside four poles.



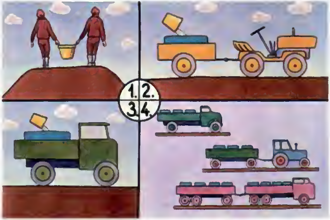
55. **The estimate of the number of advanced fry** stored in the nets is obtained on the basis of the volume of a known number of fish. **(1)** A 5-cm tea strainer should be filled with fish which are then counted one by one. **(2)** Using the same strainer, the number of such tea strainers needed to be filled with fish in order to fill a larger strainer (about 14 cm in diameter) can be obtained. The number of fish contained in the latter can be estimated by multiplying the number of fish in the small tea strainer by the number of such strainers required to fill the larger one. This larger strainer now becomes the basis for estimating numbers of **this particular population of carp fry** for transport. For example, 175 fry are counted in the small tea strainer and you need 10 small strainers to fill the large one. This large tea strainer holds 175 x 10 = 1 750 fry.



56. Before transport and stocking, the advanced carp fry are given **a quick salt bath** to control ectoparasites, *Trichodina* in particular.
(1) A 2-3% salt solution is prepared by adding 1-1.5 kg common salt to 50 l water.
(2) A piece of fine-mesh netting is placed within the container.
(3-4) Batches of fish are successively treated by being dipped for 30-40 seconds in the salt solution.
(5) The fish are then kept in clean and well-aerated water **(6)** until their transport.



57. **Advanced fry can be transported for long distances** by road or by air in plastic bags 55-60 cm in diameter and 80-90 cm high.
(1) 20 l of clean water are first poured into the bag which is carefully checked for leaks. **(2)** 2 000 to 5 000 advanced fry are placed in the water, depending on the duration of the transport, and the rest of the bag volume (at least 20 l) is filled with oxygen.
(3) The bag is tightly closed with a piece of string.
(4) It is checked again for possible leaks before it is placed in a cardboard box for transport. For additional security, the first plastic bag can be put inside a second one.



58. Advanced fry are also transported for short distances on foot in water pails **(1)** and by small tractor/trailer in fibreglass tanks **(2)**.

For longer distances such tanks are fitted on to small trucks **(3)** or larger lorries **(4)**, together with oxygen cylinders.

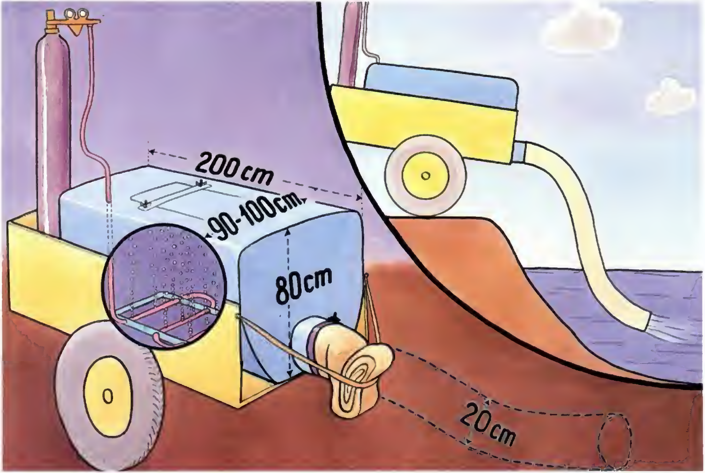
Depending on the duration of the transport, 50 000 to 100 000 advanced fry are stocked per cubic metre of water and continuous diffusion of oxygen is assured.

Remember to equalize the temperature of the water in the transport container with the storage water temperature.

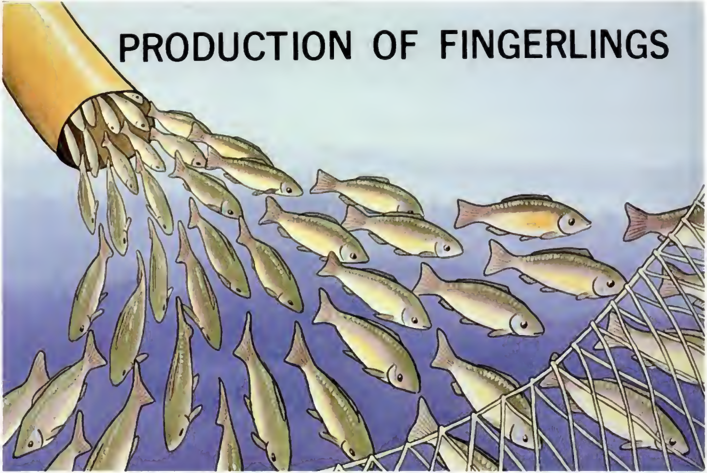
59. **Fibreglass water tanks** of about 1 m^3 capacity are very convenient for the transport of advanced fry. They can be fitted to the platform of small trailers or trucks. An oxygen cylinder is connected to a large diffuser made of plastic tubing mounted on a metal frame.

Such a water tank may safely transport up to 100 000 advanced fry for 2-3 hours, for example, around the hatchery farm.

A flexible pipe is used to transfer the fry from the tank to the pond directly.


200 cm
90-100cm
80cm
20cm

PRODUCTION OF FINGERLINGS

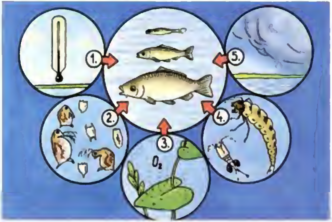


60. PRODUCTION OF FINGERLINGS

The objective of the second rearing period is to grow the advanced carp fry to the fingerling size of 10-40 g.

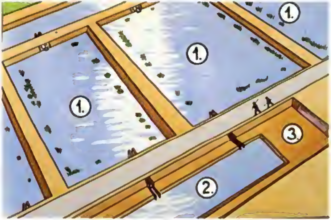
In temperate climates this period generally lasts 3-4 months from July to October.

In comparison with the first rearing period the chances of good survival are much higher and the fish require less protection.



61. The following are the main **environmental factors** which influence carp fingerling production during this second rearing period. **(1)** Warm water temperatures will accelerate growth and increase production. **(3)** The water-dissolved oxygen content should remain high (5-8 mg/l) for best results. **(4)** Predators may still cause great losses, particularly the larger ones such as frogs and birds.

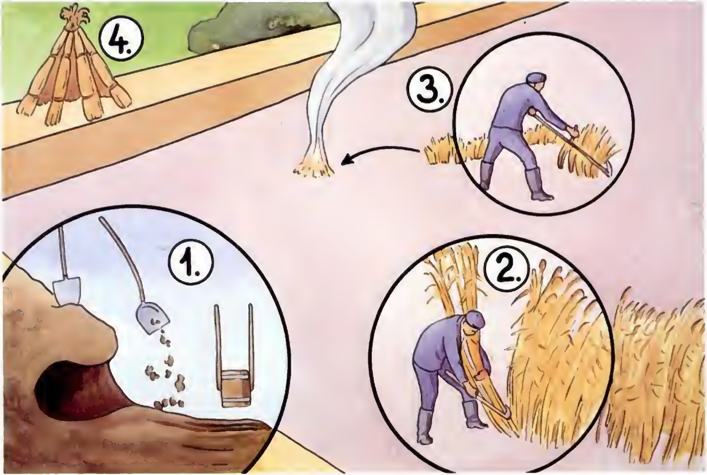
(2) The importance of the quality and availability of natural food gradually decreases as the fry grow older and artificial food is introduced. **(5)** The weather conditions also become less vital, now that the fish have reached a larger size.

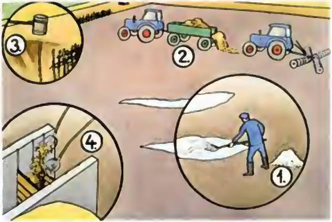


62. **(1) The fingerling ponds** are larger, generally ranging from 1 to 10 ha. Their depth varies from 1 to 1.5 m. They should have a good water supply large enough to fill the pond rapidly.

(2) The outlet structure generally consists of a monk but for the larger ponds it is advisable to build outside fishing channels also. Several ponds may be drained through a common fishing channel. **(3)** Next to the harvesting area a working platform with road access is built where large quantities of fish may be efficiently handled for sorting, weighing, and transport loading. The banks of such large ponds should be protected against wave action by allowing the growth of emerged aquatic plants such as reeds along the wind-exposed banks.

63. The fingerling ponds are kept dry during winter.
In early spring they are **repaired** and **cleaned.**
(1) The damaged banks are rebuilt.
(2) The dry permanent vegetation which protects the banks is cut short so that it will produce new shoots soon.
(3) The whole bottom surface is stripped of vegetation.
(4) The reeds *(Phragmites communis)* are prepared for sale.


4.
3.
1.
2.



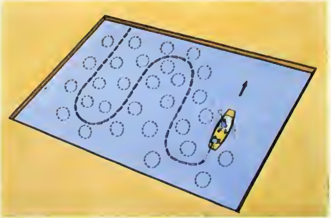
64. When the climate becomes warmer, it is time **to prepare the ponds** before filling them with water.

(1) The wet parts of the pond bottom are limed with an average dose of 150 kg/ha.

(2) Organic fertilizers such as pig or chicken manure are spread over the entire surface (2-3 tonnes/ha), and this is followed by a very shallow loosening of the bottom soil.

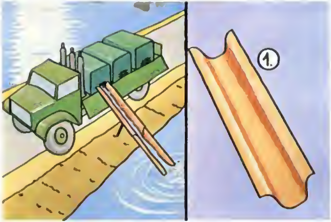
(3) The most exposed banks are protected, where necessary, with woven branches.

(4) The water outlet of the pond is sealed with two rows of planks and clayey soil. The pond is then rapidly filled with water.

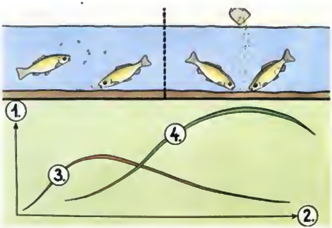


65. **Inorganic fertilizers** are applied when the pond is completely filled.

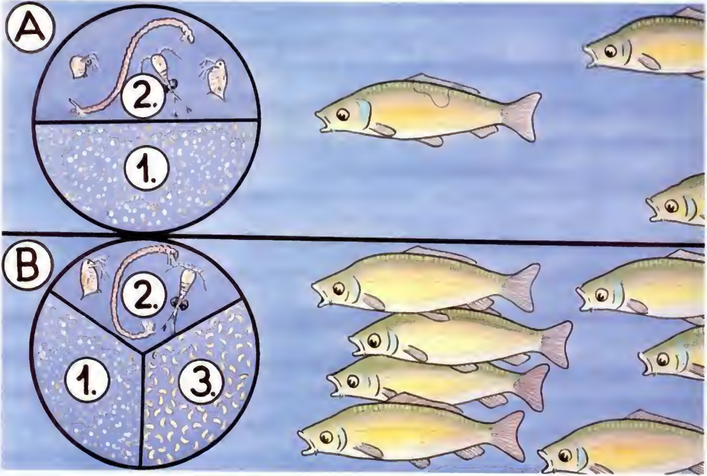
Superphosphate (100 kg/ha) and ammonium nitrate (150 kg/ha) are spread over the entire surface of the water from a boat.



66. As described earlier — see items 57, 58 and 59 — **the advanced fry are transported** by various means in water pails, plastic bags and water tanks. The transport takes place preferably during the coolest hours of the day.
On arrival at the pond the temperature of the water in the containers is equalized within 2-3°C with the temperature of the pond water.
A plastic chute **(1)** is used to transfer the fry from large lorries directly into the pond. The stocking rate of the fingerling ponds ranges from 50 000 to 100 000 ind./ha depending on the size of the pond and its productivity potential.
Smaller productive ponds are stocked at the highest density.



67. **The feeding regime** of the advanced fry changes as they grow larger.
When considering the amount of food consumed **(1)** versus time **(2)**, large zooplankters and other kinds of **natural food**, especially chironomids, gain importance at first until they reach a peak after about a month **(3)**.
It is therefore advisable to favour the development of large zooplankton and bottom fauna populations by means of fertilization to support the growth of the advanced fry at the beginning.
Later, it is the artificial food which steadily gains importance **(4)**.


A
2.
1.
B
2.
1.
3.

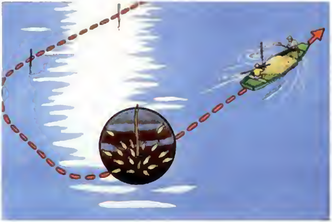
68. As the carp grow, **the daily ration of artificial food** expressed in percent of the weight of fish should be progressively reduced. It should be further reduced as the water temperature drops, especially when it becomes less than 12°C. Carp stop feeding completely at around 7°C.

With a low fish density of about 50 000 ind./ha **(A)** the food of the advanced fry consists, in equal proportions, of artificial **(1)** and natural **(2)** feed. The artificial food contains mainly ground wheat and is distributed at the maximum daily rate of 10% of the fish biomass.

With a high fish density of at least 100 000 ind./ha **(B)**, the food of the fish consists of little natural food **(2)** and, in roughly equal proportions, of two kinds of artificial feed.

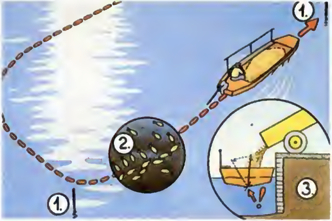
Ground wheat is distributed at the maximum daily rate of 10% of the fish biomass **(1)**

A balanced food containing about 30% protein (half of animal origin) is distributed daily at the rate of 5-10% of the fish biomass **(3)**. This last food is supplied as 3-mm dry sinking pellets.

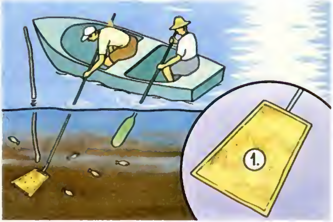


69. **The artificial food is distributed** daily from a boat, at fixed feeding stations identified by wooden poles.

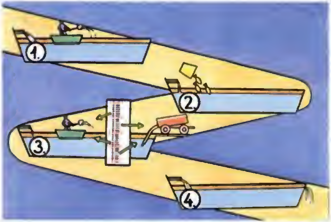
About 5-7 feeding stations per hectare are chosen around the fingerling pond.



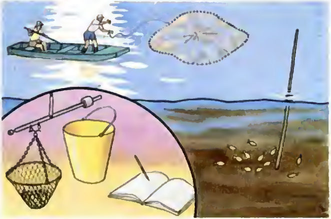
70. **Special feeding boats** are generally used on the larger ponds.
(3) There is an opening along the bottom of the boat, whose width may be regulated by the boat driver.
(2) The feed is taken out by the water current as the boat moves along feeding lines (1) identified in the pond with wooden poles.



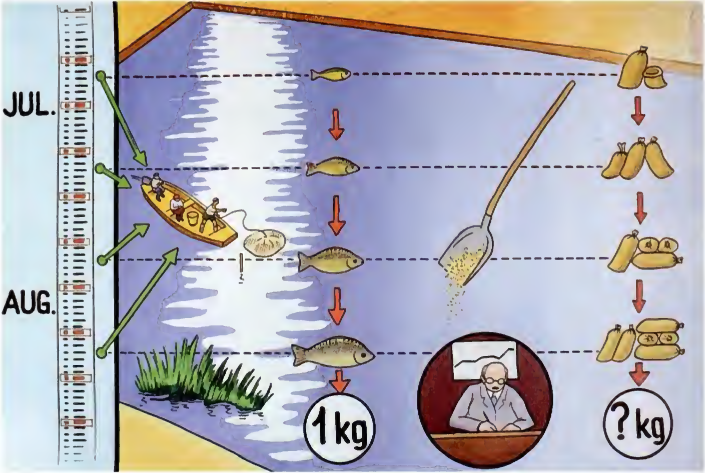
71. The daily rations of artificial food are adjusted to the appetite of the fish. **The consumption of the feed** is regularly checked by the fishermen, using a light scooper made of fine-mesh metal netting, for example (1).
Two to three hours after the morning food distribution, a few feeding stations are checked with the scooper. If there is no food left, the daily ration will be slightly increased the following day.
If a lot of food is still present, a second check is made 5-6 hours later; if much food can still be found, the daily ration for future days will be decreased.



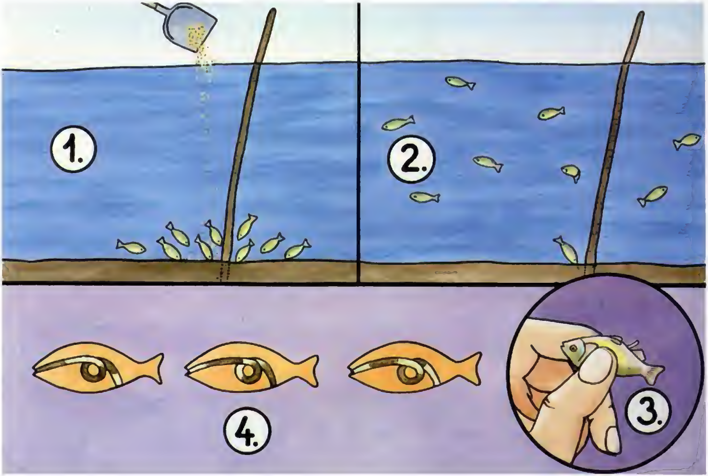
72. **The water management** of the fingerling ponds consists in keeping the level constant throughout the rearing period.
(1) The pond is filled full and fertilized.
(2) The fish are stocked. Every two weeks, the pond water is fertilized in an effort to keep the level of plankton production constant. **(3)** Liquid pig manure in particular is distributed along the banks at the rate of 10 m^3/ha of pond. Superphosphate (20-30 kg/ha) and ammonium nitrate (20-30 kg/ha) are spread over the entire surface from a boat.
(4) Toward the end of the rearing period when there is danger of overstocking, the water supply is increased to create a stronger flow through the pond.



73. **The fish are sampled** every 2-3 weeks at the feeding stations. A few hundred fish from each fingerling pond are caught in a casting net. The average individual weight is calculated from their total weight and number. On the basis of the quantity of artificial food distributed between successive controls, **the food conversion rate** is calculated and the efficiency of the pond production evaluated.
If the food conversion rate does not exceed 3.5 to 4, production efficiency is good. When the food conversion rate becomes higher, the reason for the drop in efficiency should be investigated. It is usually due to the presence of disease or parasites, or to a decline in the availability of natural food. Remedial measures are then applied and the production efficiency reestablished to an acceptable level.


JUL.
AUG.
1 kg
? kg

74. This **example** shows how to set about **evaluating production efficiency** in a fingerling pond during a specific two-week period.
At the start of this period, the average weight of the carp has already been found to be 1 g by means of the previous sampling. As the stock of advanced fry was 100 000, the standing crop was then 1 g x 100 000 = 100 kg.
At the end of the period, two weeks later, it can be determined from the sampling that the carp now average 2 g. So the standing crop is 2 g x 100 000 = 200 kg and the production during the last two weeks has been 200 kg — 100 kg = 100 kg.
An average daily ration equal to 15% of the fish biomass present at the beginning of the period has been fed and 0.15 x 100 kg = 15 kg artificial food have been distributed each day.
During the entire period under examination, 15 kg x 14 days = 210 kg have been distributed. These 210 kg of food have resulted in a 100-kg carp production and therefore the food conversion rate is 210 kg : 100 kg = 2.1.
It is concluded that the efficiency of the fish production during the last two weeks has been good in this particular fingerling pond.


1.
2.
3.
4.

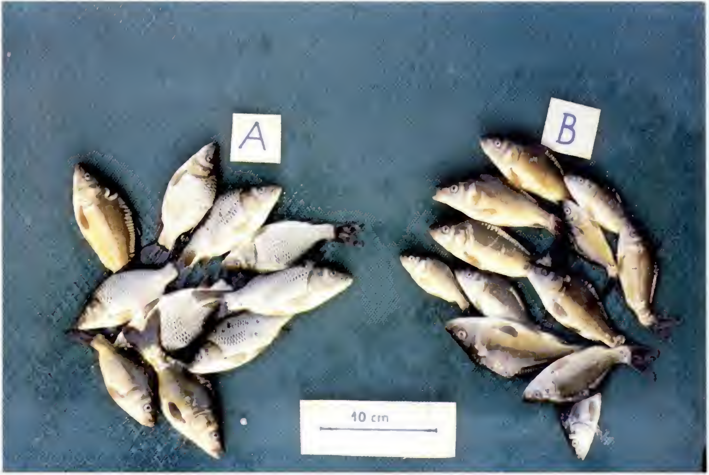
75. The sampled fish are also examined **to determine their feeding regime.**

(1) After the distribution of artificial food the carp fry eat it, **(2)** but later they collect natural food organisms from the water column and from the bottom.

(3) To estimate the proportion in which these two types of food are consumed by the carp fry, the fish farmer presses the fish body laterally and obtains some intestinal content.

(4) According to its colour he can tell which type of food the fish has eaten, natural food (dark) or artificial food (greyish/white). If the whole intestinal tract can be examined, the two types of food will generally be found alternating.

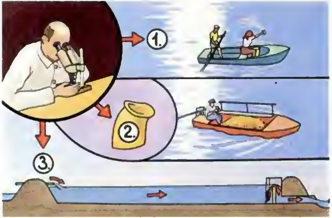
When the relative amount of dark areas decreases, it indicates that carp have changed their feeding regime in favour of artificial food and that the addition of some high protein pellets to the feeding ration may become necessary.



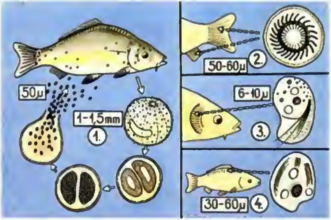
A
B
10 cm

76. **What is a "good" or a "bad" fingerling?**

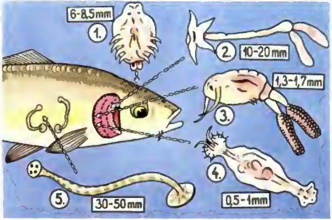
	(A) Good fingerling	(B) Bad fingerling
Body shape:	deep, plump	slender, bighead
Colour:		
belly	deep yellow	yellowish
back	greyish green	dark
tail	bright, shiny	dull



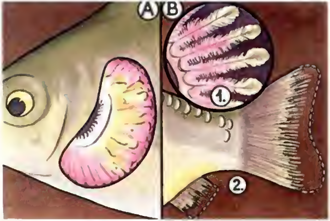
77. **The health aspects** of some of the sampled fish should be examined under a binocular microscope. This is best done by a biologist or a veterinary doctor.
If necessary, therapeutic treatments are applied, such as **(1)** the chemical treatment of the pond water or **(2)** the distribution of medicated feed.
(3) In simpler cases, an increased water exchange through the pond may be sufficient.



78. Most common in the fingerling ponds during the warm season are **the monocellular ectoparasites** such as *Ichthyophthirius multifilis*, the white spot disease or "ich".
(1) The pond is treated against these with malachite green at the final concentration of 0.1 ppm. Also very common are: **(2)** *Trichodina* on the fins, **(3)** *Costia* on the gills, and **(4)** *Chilodonella* on the gills and fins.
For these last three parasites the pond is treated with copper oxychloride at the final concentration of 4 ppm.

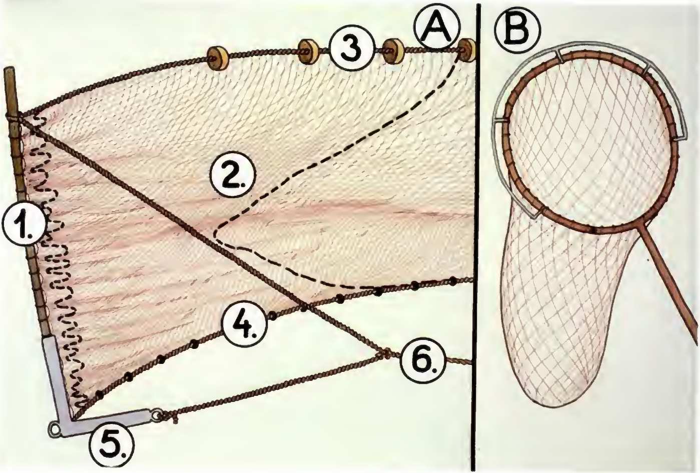


79. Other **ectoparasites** can also cause great damage if they become numerous and remain unchecked, as for example: **(1)** *Argulus foliaceus*, **(2)** *Lernaea cyprinacea*, **(3)** *Ergasilus sieboldi*, **(4)** *Dactylogyrus vastator*, and the leech **(5)** *Piscicola geometra*.
The pond should be treated with an agricultural insecticide – see item 34 – at the final concentration of 1 ppm, or 1 g/m^3.

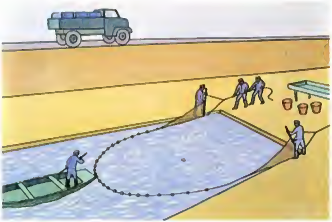


80. Occasionally serious fish diseases may develop in the fingerling ponds. In such cases, the advice of a veterinarian becomes necessary.
Examples are: **(A)** the **gill rot** and **gill necrosis** caused by the combined action of a fungus and bacteria, in adverse environments. The treatment consists in treating the pond with chlorinated lime (1 ppm) and increasing the water exchange.
(B) (1) Gill infection and **(2) fin rot** are bacterial diseases. Small ponds can be treated with malachite green (0.1 ppm), but in large ponds only chlorinated lime (1 ppm) can be used. The water exchange should then be increased.

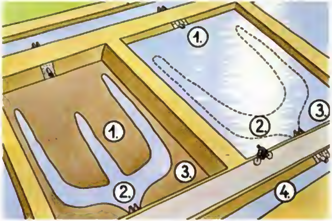
81. By the end of the second rearing period which lasts for 3-4 months, the advanced carp fry have grown into **fingerlings**. The average survival rate is normally 80%.
The yield ranges from 1 to 2 t/ha.
The carp fingerlings, also called "yearlings" in temperate countries, have a total length ranging from 8-12 cm and a live weight varying from 10 to 40 g.


A
B
1.
2.
3
4.
5.
6.

82. At the end of the second rearing period, **(A) the fingerlings are harvested** with large seine nets.
These nets are 20-30 m long and 2.5 m high.
(2) Their 10-15-mm mesh netting is attached on each side at regular intervals, to **(1)** 1.5 m wooden poles to form a baggy shape.
(3) The top of the netting is mounted on a rope with floats while **(4)** its bottom part is mounted on a rope with sinkers.
(5) Two corners are reinforced with steel tubing.
The seine is slowly pulled vertically along the pond bottom through two long ropes.
(6) Each of them is attached both at the top and the bottom of the wooden poles.
(B) During the harvest, double-frame dip nets (30 cm diameter) are frequently used, too.



83. The fingerlings are transferred through the outlet structure from the large rearing pond to the outside **fishing channel,** as the water is slowly drained from the pond.
The channel is then repeatedly fished with the seine net toward the working platform where the fish are harvested.
All this should be done early in the morning before the air temperature warms up.



84. **In rearing ponds not connected to a fishing channel, (1)** the water is partly drained so that more than half the pond becomes dry. **(2)** Water and fish are now concentrated in the deeper channels and in the lower part of the pond.

(3) These areas are fished with the seine net toward the harvesting areas, near the access road and next to the monk.

Finally, the last part of the harvest is collected in front of the monk where a **fishing pit** is sometimes built. **(4)** The water drains out of the pond into the draining canal **(4)**.

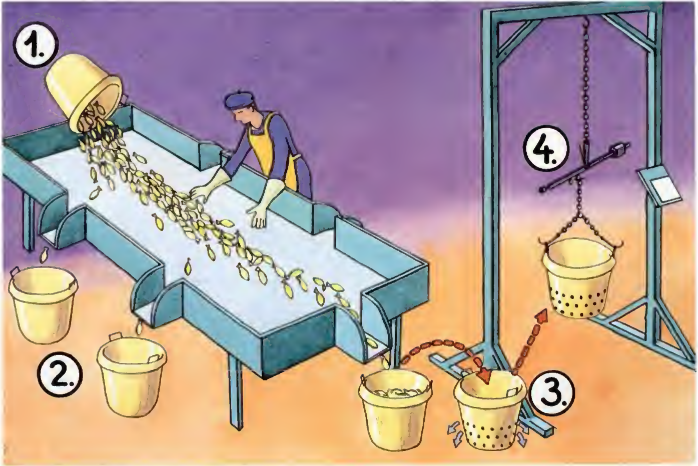
85. The harvested fingerlings are brought to the **sorting table** where they are sorted by size and, if necessary, by species.

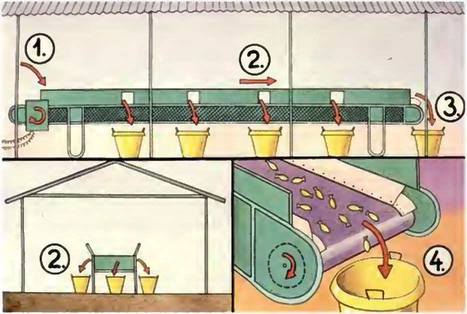
(1) The fish are poured onto the table.

Several fishermen sort the fish rapidly, **(2)** pushing the various sizes through side apertures into different 50-l water containers. The live carp are kept in these containers only for a short time. They are then immediately placed in clean water again, usually in a transport container.

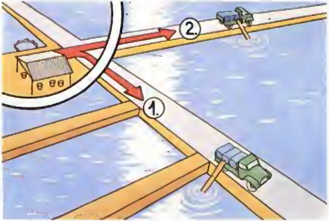
All these operations usually take place in an open shed built on a working platform.

As the fingerlings have to be kept alive, it is important that they remain out of the water as little as possible and that the work proceeds with diligence and efficiency.

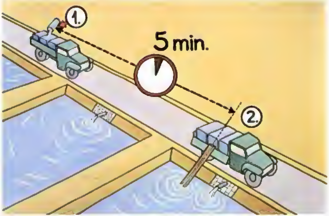

1.
2.
3.
4.



86. For sorting large quantities of fish, a **rubber conveyor belt** moving horizontally is used.
(1) The harvested fingerlings are transferred to the head of the conveyor belt. As they are moved along, **(2)** they are sorted by fishermen into water containers.
(3-4) The most abundant size/species is left on the belt to drop at the end either into a large container or into a chute and a storage basin which can be fished later.



87. The sorted fingerlings are transported from the harvesting site and stocked in either **(1)** storage ponds or **(2)** fattening ponds.
In the first case, the fish will be marketed outside the farm or they will overwinter, as discussed in the next section.
In the second case, the fingerlings will continue to grow until they reach marketable size.



88. During transportation, a **chemical treatment** may be applied for the elimination of ectoparasites.
In such cases, five minutes before reaching the pond where the carp will be stocked, a mixed solution of three chemicals is poured into the transport container as follows: common salt (final concentration 2 kg/m^3), agricultural insecticide (200 g/m^3), and malachite green (0.1 ppm).
For this last chemical, a stock solution is first prepared by mixing 20 g (1 tablespoon) of malachite green with 100 l water. To obtain a 0.1-ppm concentration, 0.5 l of this stock solution per cubic metre water in the fish container is used.

OVERWINTERING SEASON

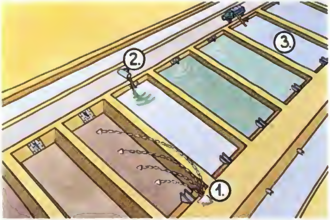
89. THE OVERWINTERING SEASON

In temperate climates when the water temperature reaches below 10°C, the overwintering season starts.

In Hungary near Budapest, this season lasts for about five months from November to March.

Wintering ponds are relatively small (600 - 1 000 m^2) and deep (2 m).

Since common carp consume very little food below 10°C and stop feeding at 7°C, there is **no food distribution** in the wintering ponds.

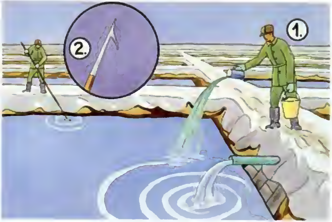


90. **The preparation of the wintering ponds** involves several operations.

(1) The pond bottom is treated with lime (200 kg/ha) and the pond is filled with water. **(2)** The pond water is then treated with malachite green (5 mg/l) to prevent infections. **(3)** This chemical is progressively washed out and **the fingerlings are stocked** at the rate of 100 kg per 10 l/minute water inflow.

For example, 1 000-m^2 wintering ponds, 2 m deep, and equipped with an inlet pipe of 20 cm diameter, receive a maximum water inflow of 600 l/min.

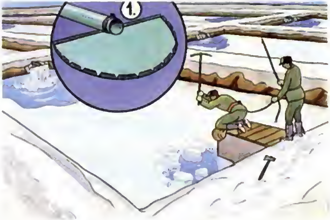
In such ponds a maximum of 6 t of fingerlings can be overwintered, which represents an average fish density of 3 kg/m^3.



91. Every week **the malachite green treatment** of the pond water is repeated, but at the lower concentration of 0.1 mg/l.
The necessary quantity of malachite green is dissolved in a bucket of water. **(1)** Half of this solution is poured close to the water inlet, the other half being distributed around the pond.
(2) Every day the dead fish are removed from the pond, if necessary using a grappling hook.

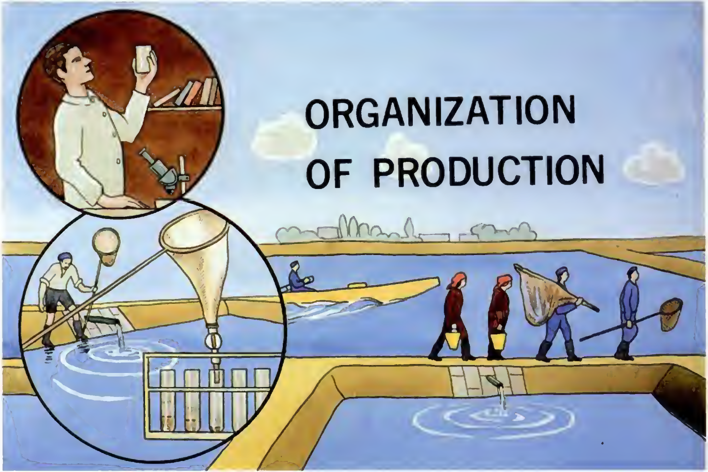
BIOLOGY OF JUVENILES PRODUCTION IN EARTHEN PONDS

92. Every week, too, **fish are sampled** using a casting net. Their **health condition** is checked by a specialized veterinarian.
Just as ectoparasitic infections predominate in warm conditions, bacterial and viral diseases are particularly common in cold water.



93. When **ice** covers the wintering pond it should be removed around the monk.
(1) A **spreading plate** is fixed under the water inflow to increase the oxygenation of the water.

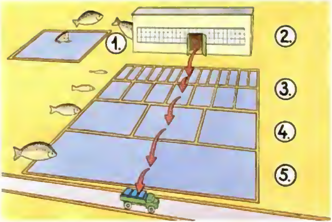
94. Because of the high density of fingerlings in the wintering pond and their slow swimming, they are easily caught by **predatory water birds** such as gulls. It is important to keep these birds away from the ponds.



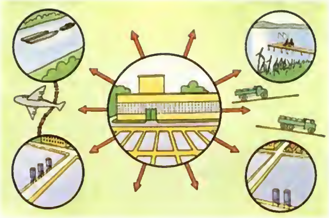
ORGANIZATION OF PRODUCTION

95. ORGANIZATION OF FISH PRODUCTION

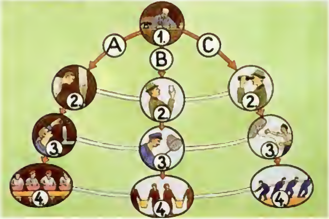
The mass production of advanced carp fry and fingerlings in earthen ponds is the second step in the general scheme of food fish production. Its success depends to a large extent on efficient organization.



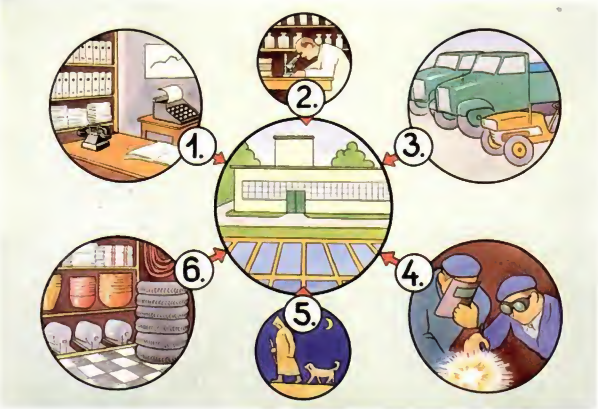
96. As shown in **Part 1, (1)** good broodstock management prepares selected carp breeders for their successful artificial propagation and the mass production of early fry **(2)** in the hatchery.
In this **Part 2,** the use of earthen ponds for the subsequent mass production of **(3)** advanced fry and **(4)** fingerlings has been illustrated.
In temperate climates, these four production phases take place during the first growing season. **(5)** They are followed during the next two years by the production of fish for the table in fattening ponds **(5).**
In warmer climates, the complete production cycle can be shortened by at least one year if carp growth progresses throughout most of the year.



97. The carp fingerlings which are not further grown by the producer can be sold to others to be used in various ways. They may be stocked in **natural waters** such as lakes and rivers, either to improve the natural stocks or to support sport fishing.
They may also be stocked in ponds at other **fish farms**, either for extensive or semi-extensive production of table fish.
In temperate climates this will usually require two more growing seasons at the end of which the carp weigh from 1 to 2 kg.



98. A production manager **(1)** supervises **the staff necessary for the proper planning and execution** of the production programme in a large-scale hatchery.
In Hungary, three main production sections exist: for the production of **(A)** eggs and early fry, **(B)** advanced fry, and **(C)** fingerlings respectively.
Each of these sections is managed by an experienced technician such as **(2)** an Agricultural Engineer. Under his leadership, **(4)** skilled workers are supervised by **(3)** a Fishery Master with a lot of local experience.



99. **Support services** are very important. They may include: **(1)** administration, **(2)** fish health, **(3)** transport, **(4)** maintenance, **(5)** security and **(6)** stores.

TABLE 1

SELECTED DATA ON THE PRODUCTION OF ADVANCED FRY AND FINGERLINGS OF COMMON CARP

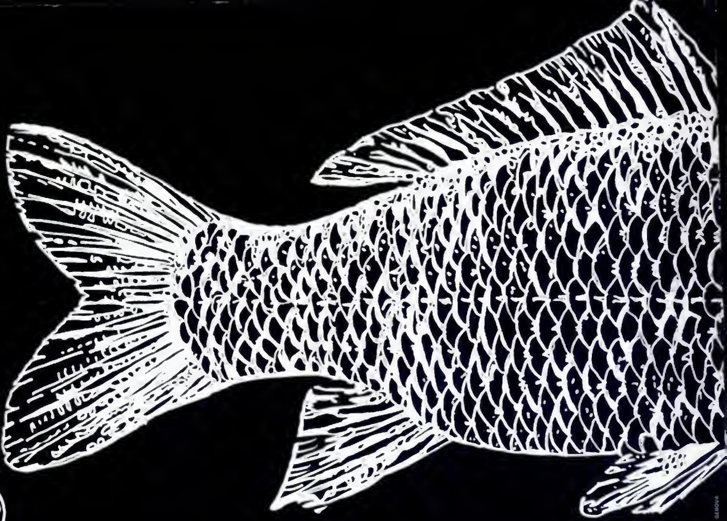
	Advanced fry production	**Fingerling production**
Duration of rearing	3-4 weeks	3-4 months
Water temperature	20-25°C	20-25°C
Size of ponds	0.01-1 ha	1-10 ha
Liming of dry ponds, kg/ha	150	wet parts only, 150
Fertilization, pond preparation	organic 5 t/ha superphosphate 100 kg/ha ammonium nitrate 150 kg/ha	organic 2-3 t/ha superphosphate 100 kg/ha ammonium nitrate 150 kg/ha
Stocking rate, ind./m^2	200-600	5-10
Stocking size	6-7 mm	2.5-3 cm/0.2-0.3 g

Food	**Advanced fry production**	**Fingerling production**
Natural	rotifers/cladoceres capepods	large zooplankters/ chironomids
Artificial	mixture soybean meal, wheat meal, fish meal, blood/ meat meal	ground wheat/balanced feed 30% protein
Size	0.1-0.2 mm particles	up to 3 mm pellets
DFR	1-5 1/100 000 ind.	10%/5-10% biomass
Harvesting size	2.5-3 cm/0.2-0.3 g	8-12 cm/10-40 g
Survival, percent	30-60	80
Yield, t/ha		1-2

WHERE TO PURCHASE FAO PUBLICATIONS LOCALLY

Algeria	Société nationale d'édition et de diffusion, 92, rue Didouche Mourad, Alger.
Argentina	Librería Agropecuaria S.A., Pasteur 743, 1028 Buenos Aires
Australia	Hunter Publications, 58A Gipps Street, Collingwood, Vic 3066 Australian Government Publishing Service, Sales and Distribution Branch, Wentworth Ave, Kingston, A.C.T. 2604 Bookshops in Adelaide, Melbourne, Brisbane, Canberra, Perth, Hobart and Sydney.
Austria	Gerold & Co., Graben 31, 1011 Vienna
Bahrain	United Schools International, PO Box 726, Manama
Bangladesh	ADAB, House No 46A, Road No 6A, Dhanmondi R/A, Dhaka
Belgium	M. J. De Lannoy, 202, avenue du Roi, 1060 Bruxelles CCP 000-0808993-13
Bolivia	Los Amigos del Libro, Peru 3712, Casilla 450, Cochabamba, Mercado 1315, La Paz
Botswana	Botsalo Books (Pty) Ltd, PO Box 1532, Gaborone
Brazil	Livraria Mestre Jou, Rua Guaipá 518, São Paulo 05089, Fundação Getulio Vargas, Praia de Botafogo 190, C.P. 9052, Rio de Janeiro, A Nossa Livraria, CLS 104, Bloco C, Lojas 18/19 70.000 Brasília, D.F
Brunei	SST Trading Sdn. Bhd., Bangunan Tekno No. 385, Jln 5/59, PO Box 227, Petaling Jaya, Selangor
Canada	Renouf Publishing Co. Ltd, 61 Sparks St (Mall), Ottawa, Ont. KIT 56; toll-free calls in Canada 1-800-267-4164, local and other calls 613-238-8985
China	China National Publications Import Corporation, PO Box 88, Beijing
Congo	Office national des librairies populaires, B.P. 577, Brazzaville
Costa Rica	Librería, Imprenta y Litografía Lehmann S.A., Apartado 10011, San José
Cuba	Ediciones Cubanas, Empresa de Comercio Exterior de Publicaciones, Obispo 461, Apartado 605, La Habana.
Cyprus	MAM, PO Box 1722, Nicosia
Czechoslovakia	ARTIA, Ve Smeckach 30, PO Box 790, 111 27 Prague 1.
Denmark	Munksgaard Export and Subscription Service, 35 Nørre Søgade, DK 1370 Copenhagen K
Dominican Rep.	Fundación Dominicana de Desarrollo, Casa de las Gárgolas, Mercedes 4, Apartado 857, Zona Postal 1, Santo Domingo
Ecuador	Su Librería Cía. Ltda., García Moreno 1172 y Mejía, Apartado 2556, Quito
El Salvador	Librería Cultural Salvadoreña S.A. de C.V., Calle Arce 423, Apartado Postal 2296, San Salvador
Finland	Akateeminen Kirjakauppa, 1 Keskuskatu, PO Box 128, 00101 Helsinki 10
France	Editions A. Pedone, 13, rue Soufflot, 75005 Paris
Germany, F.R.	Alexander Horn Internationale Buchhandlung, Friedrichstr. 39, Postfach 3340, 6200 Wiesbaden
Ghana	Fides Enterprises, PO Box 14129, Accra, Ghana Publishing Corporation, PO Box 3632, Accra
Greece	G.C. Eleftheroudakis S.A., 4 Nikis Street, Athens (T-126), John Mihalopoulos & Son S.A., 75 Hermou Street, PO Box 73, Thessaloniki
Guatemala	Distribuciones Culturales y Técnicas «Artemis», 5a. Avenida 12-11, Zona 1, Apartado Postal 2923, Guatemala
Guinea-Bissau	Conselho Nacional da Cultura, Avenida da Unidade Africana, C.P. 294, Bissau
Guyana	Guyana National Trading Corporation Ltd, 45-47 Water Street, PO Box 308, Georgetown
Haiti	Librairie "A la Caravelle", 26, rue Bonne Foi, B.P. 111, Port-au-Prince
Hong Kong	Swindon Book Co., 13-15 Lock Road, Kowloon
Hungary	Kultura, PO Box 149, 1389 Budapest 62
Iceland	Snaebjörn Jónsson and Co. h.f., Hafnarstraeti 9, PO Box 1131, 101 Reykjavik
India	Oxford Book and Stationery Co., Scindia House, New Delhi 100 001; 17 Park Street, Calcutta 700 016, Oxford Subscription Agency, Institute for Development Education, 1 Anasuya Ave, Kilpauk, Madras 600 010.
Indonesia	P.T. Inti Buku Agung, 13 Kwitang, Jakarta
Iraq	National House for Publishing, Distributing and Advertising, Jamhuria Street, Baghdad.
Ireland	The Controller, Stationery Office, Dublin 4
Italy	Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100 Rome. Libreria Scientifica Dott. Lucio de Biasio "Aeiou", Via Meravigli 16, 20123 Milan, Libreria Commissionaria Sansoni S.p.A. "Licosa", Via Lamarmora 45, C.P. 552, 50121 Florence
Japan	Maruzen Company Ltd, PO Box 5050, Tokyo International 100-31.
Kenya	Text Book Centre Ltd, Kijabe Street, PO Box 47540, Nairobi
Korea, Rep. of	Eulyoo Publishing Co. Ltd, 46-1 Susong-Dong, Jongro-Gu, PO Box 362, Kwangwha-Mun, Seoul 110
Kuwait	The Kuwait Bookshops Co. Ltd, PO Box 2942, Safat
Luxembourg	M. J. De Lannoy, 202, avenue du Roi, 1060 Bruxelles (Belgique)

Malaysia	SST Trading Sdn. Bhd., Bangunan Tekno No. 385, Jln 5/59, PO Box 227, Petaling Jaya, Selangor.
Mauritius	Nalanda Company Limited, 30 Bourbon Street, Port-Louis
Mexico	Dilitsa S.A., Puebla 182-D, Apartado 24-448, México 06700, D.F
Morocco	Librairie "Aux Belles Images", 281, avenue Mohammed V, Rabat
Netherlands	Keesing Boeken V.B., Joan Muyskenweg 22, Postbus 1118, 1000 BC Amsterdam.
New Zealand	Government Printing Office, Government Printing Office Bookshops: 25 Rutland Street, Mail orders: 85 Beach Road, Private Bag, CPO, Auckland; Ward Street, Hamilton; Mulgrave Street (Head Office), Cubacade World Trade Centre, Wellington; 159 Hereford Street, Christchurch; Princes Street, Dunedin
Nicaragua	Librería Universitaria, Universidad Centroamérica, Apartado 69, Managua
Nigeria	University Bookshop (Nigeria) Limited, University of Ibadan, Ibadan
Norway	Johan Grundt Tanum Bokhandel, Karl Johansgate 41-43, PO Box 1177, Sentrum, Oslo 1
Pakistan	Mirza Book Agency, 65 Shahrah-e-Quaid-e-Azam, PO Box 729, Lahore 3; Sasi Book Store, Zaibunnisa Street, Karachi
Panama	Distribuidora Lewis S.A., Edificio Dorasol, Calle 25 y Avenida Balboa, Apartado 1634, Panama 1
Paraguay	Agencia de Librerías Nizza S.A., Casilla 2596, Eligio Ayala 1073, Asunción
Peru	Librería Distribuidora «Santa Rosa», Jirón Apurimac 375, Casilla 4937, Lima 1.
Philippines	The Modern Book Company Inc., PO Box 632, Manila
Poland	Ars Polona, Krakowskie Przedmiescie 7, 00-068 Warsaw
Portugal	Livraria Bertrand, S.A.R.L., Rua João de Deus, Venda Nova, Apartado 37, 2701 Amadora Codex; Livraria Portugal, Dias y Andrade Lda., Rua do Carmo 70-74, Apartado 2681, 1117 Lisbonne Codex
Romania	Ilexim, Str. 13 Dicembrie No. 3-5, Bucharest Sector 1
Saudi Arabia	The Modern Commercial University Bookshop, PO Box 394, Riyadh
Singapore	MPH Distributors (S) Pte. Ltd. 71/77 Stamford Road, Singapore 6; Select Books Pte. Ltd. 215 Tanglin Shopping Centre, 19 Tanglin Road, Singapore 1024; SST Trading Sdn. Bhd., Bangunan Tekno No. 385, Jln 5/59, PO Box 227, Petaling Jaya, Selangor
Somalia	"Samater's", PO Box 936, Mogadishu
Spain	Mundi-Prensa Libros S.A., Castelló 37, Madrid 1; Librería Agrícola, Fernando VI 2, Madrid 4
Sri Lanka	M.D. Gunasena & Co. Ltd. 217 Olcott Mawatha, PO Box 246, Colombo 11
Sudan	University Bookshop, University of Khartoum, PO Box 321, Khartoum
Suriname	VACO n.v. in Suriname, Domineestraat 26, PO Box 1841, Paramanbo
Sweden	Books and documents: C.E. Fritzes Kungl. Hovbokhandel, Regeringsgatan 12, PO Box 16356, 103 27 Stockholm. Subscriptions: Vennergren-Williams AB, PO Box 30004, 104 25 Stockholm
Switzerland	Librairie Payot S.A., Lausanne and Geneva; Buchhandlung und Antiquariat Heinimann & Co., Kirchgasse 17, 8001 Zurich
Tanzania	Dar-es-Salaam Bookshop, PO Box 9030, Dar-es-Salaam; Bookshop, University of Dar-es-Salaam, PO Box 893, Morogoro
Thailand	Suksapan Panit, Mansion 9, Rajadamnern Avenue, Bangkok
Togo	Librairie du Bon Pasteur, B.P. 1164, Lomé
Tunisia	Société tunisienne de diffusion, 5, avenue de Carthage, Tunis
Turkey	Kultur Yayinlari Is-Turk Ltd Sti., Ataturk Bulvari No. 191, Kat. 21, Ankara. Bookshops in Istanbul and Izmir
United Kingdom	Her Majesty's Stationery Office, 49 High Holborn, London WC1V 6HB (callers only); HMSO Publications Centre, Agency Section, 51 Nine Elms Lane, London SW8 5DR (trade and London area mail orders); 13a Castle Street, Edinburgh EH2 3AR; 80 Chichester Street, Belfast BT1 4JY; Brazennose Street, Manchester M60 8AS; 258 Broad Street, Birmingham B1 2HE; Southey House, Wine Street, Bristol BS1 2BQ.
United States of America	UNIPUB, PO Box 1222, Ann Arbor, MI 48106
Uruguay	Librería Agropecuaria S.R.L., Alzaibar 1328, c.c. 1755, Montevideo.
Yugoslavia	Jugoslovenska Knjiga, Trg. Republike 5/8, PO Box 36, 11001 Belgrade; Cankarjeva Zalozba, PO Box 201-IV, 61001 Ljubljana
Zambia	Kingstons (Zambia) Ltd, Kingstons Building, President Avenue, PO Box 139, Ndola
Other countries	Requests from countries where sales agents have not yet been appointed may be sent to: Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy



Food and Agriculture Organization of the United Nations

P-44

ISBN 92-5-102302-6

STAMPA S.p.A. GENOVA